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(54) **WATER SUPPLY APPARATUS IN REFRIGERATOR**

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F25D 23/02	(2006.01)
F25C 1/22	(2006.01)
F25D 23/08	(2006.01)
F25D 23/12	(2006.01)

(52) **U.S. Cl.**

CPC ***F25C 1/225*** (2013.01); ***F25D 23/02*** (2013.01); *F25D 23/082* (2013.01); *F25D 23/126* (2013.01); *F25D 2323/024* (2013.01)

(58) **Field of Classification Search**

CPC F25C 1/225; F25C 2400/14; F25D 2323/024; F25D 23/082; F25D 23/02

USPC 62/377, 137, 74, 344, 449, 340, 347

See application file for complete search history.

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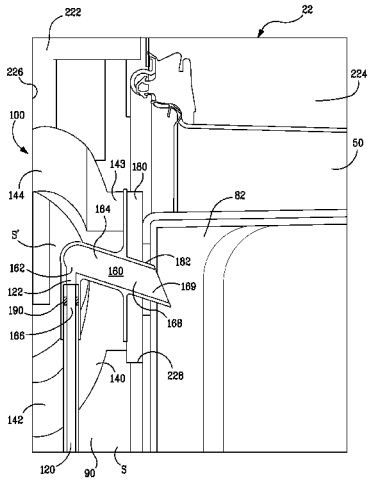
(57) **ABSTRACT**

A water supply apparatus arranged in a door of a refrigerator, for conveying water to an icemaker of the refrigerator. The apparatus has a water tube for delivering water from a water source, a support block attached to an inner surface of the door, a fill tube assembled to the support block and in fluid communication with the water tube, and a gasket disposed between the support block and the door for sealing an insulator in the door. The gasket has a hole through which the fill tube extends to convey the water from the water tube to the icemaker.

16 Claims, 8 Drawing Sheets



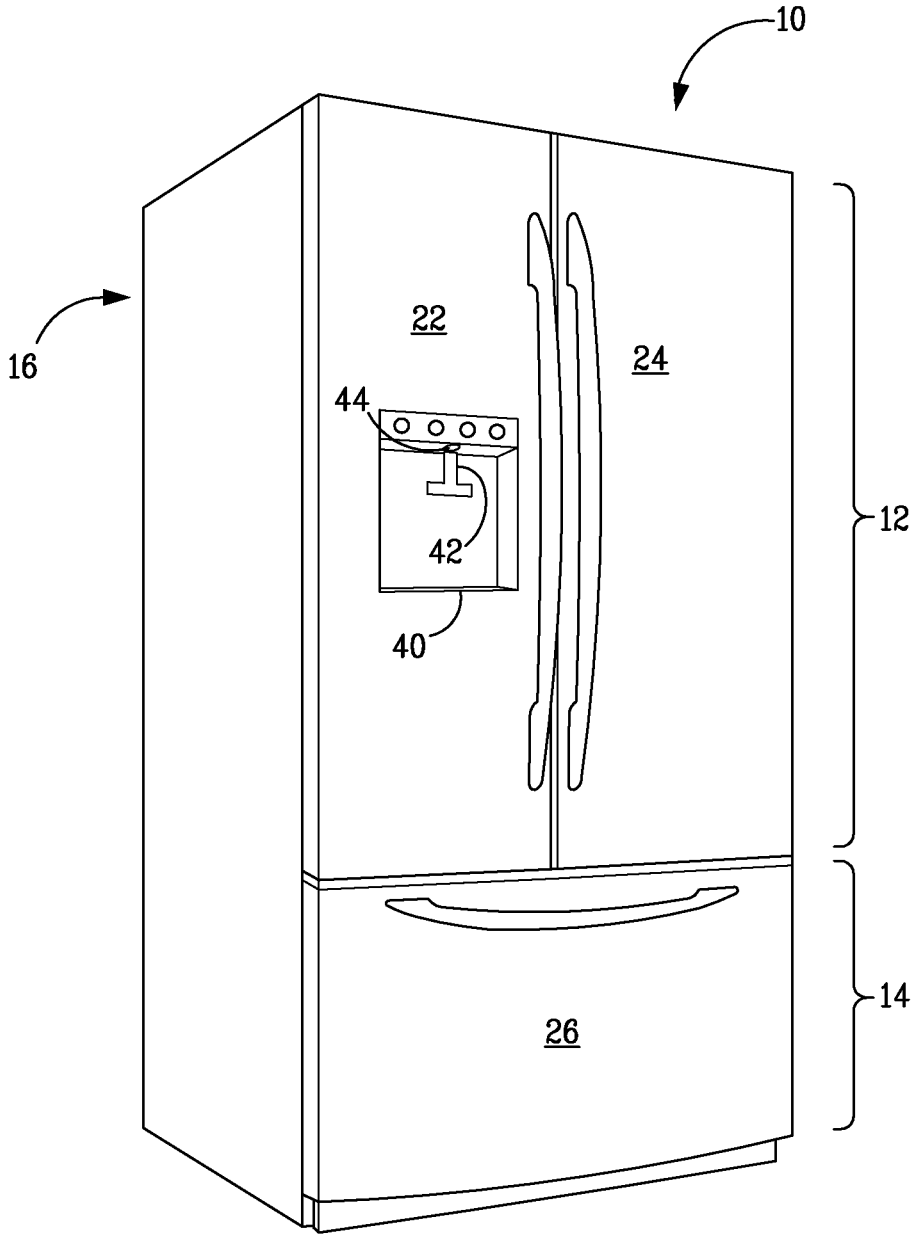


FIG. 1

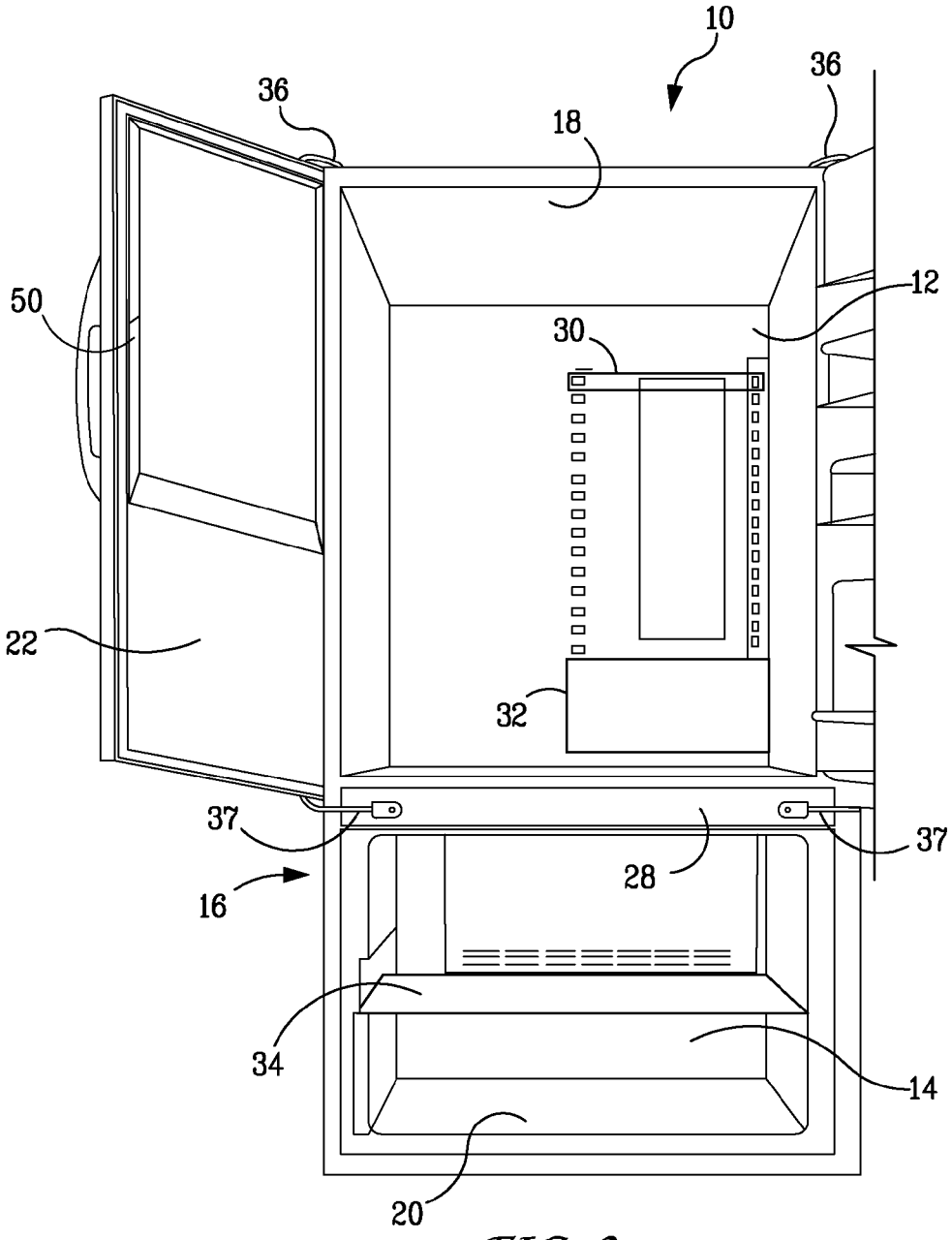


FIG. 2

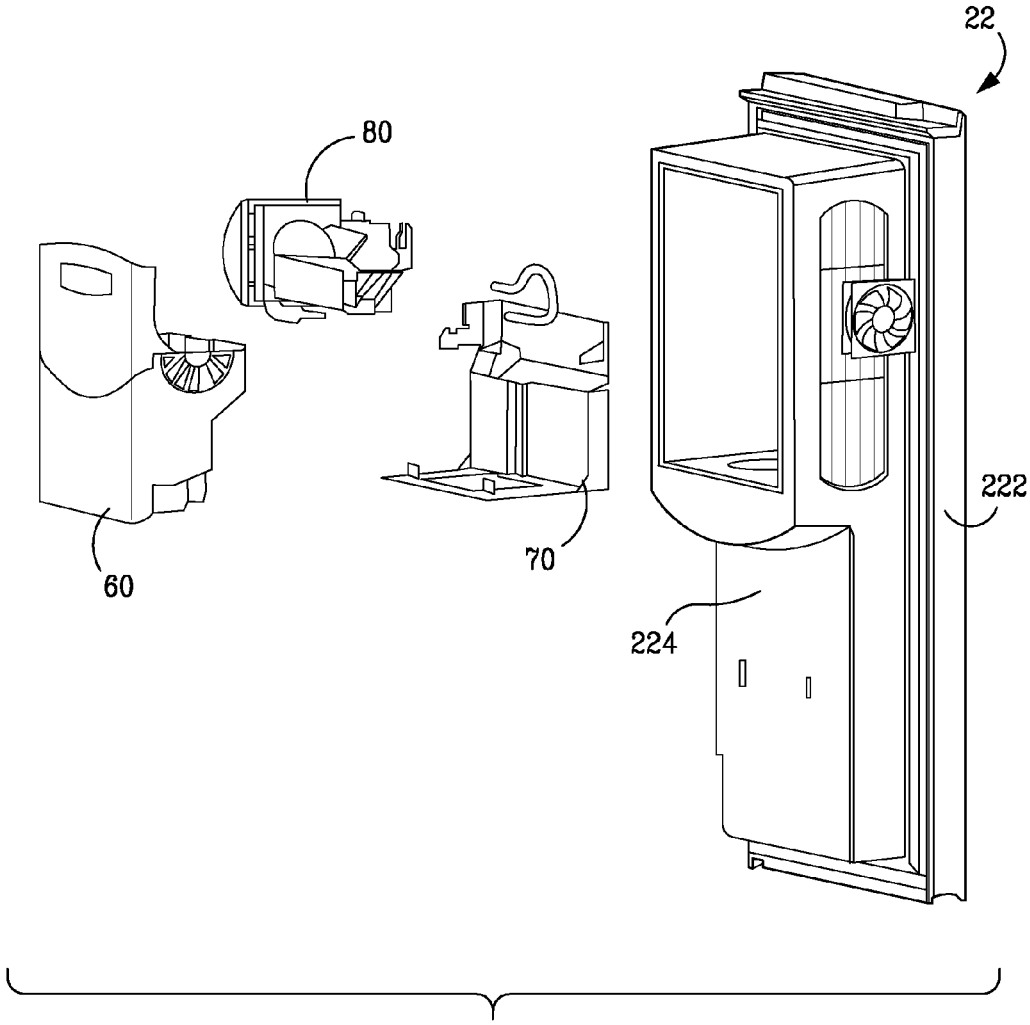


FIG. 3

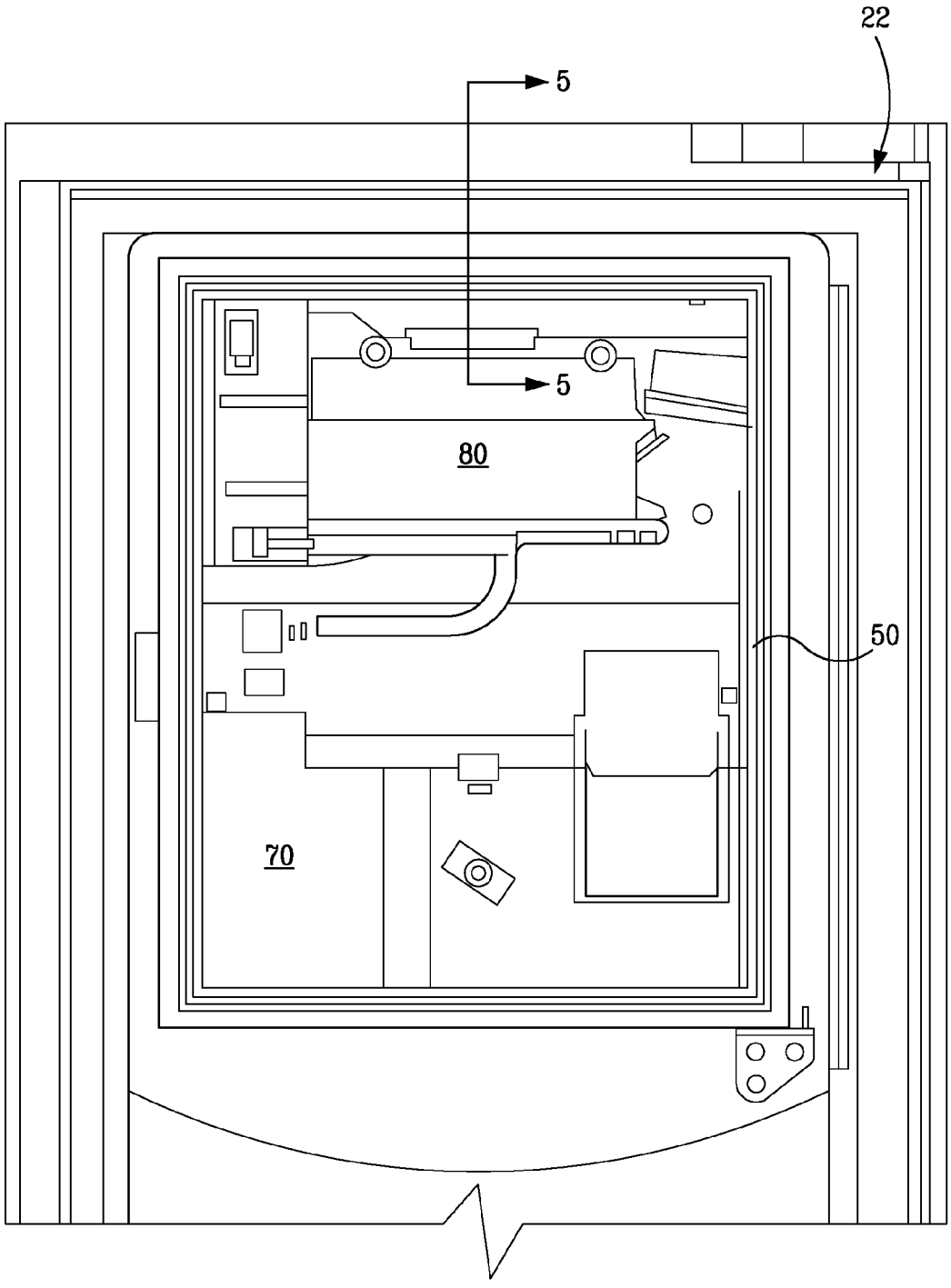


FIG. 4

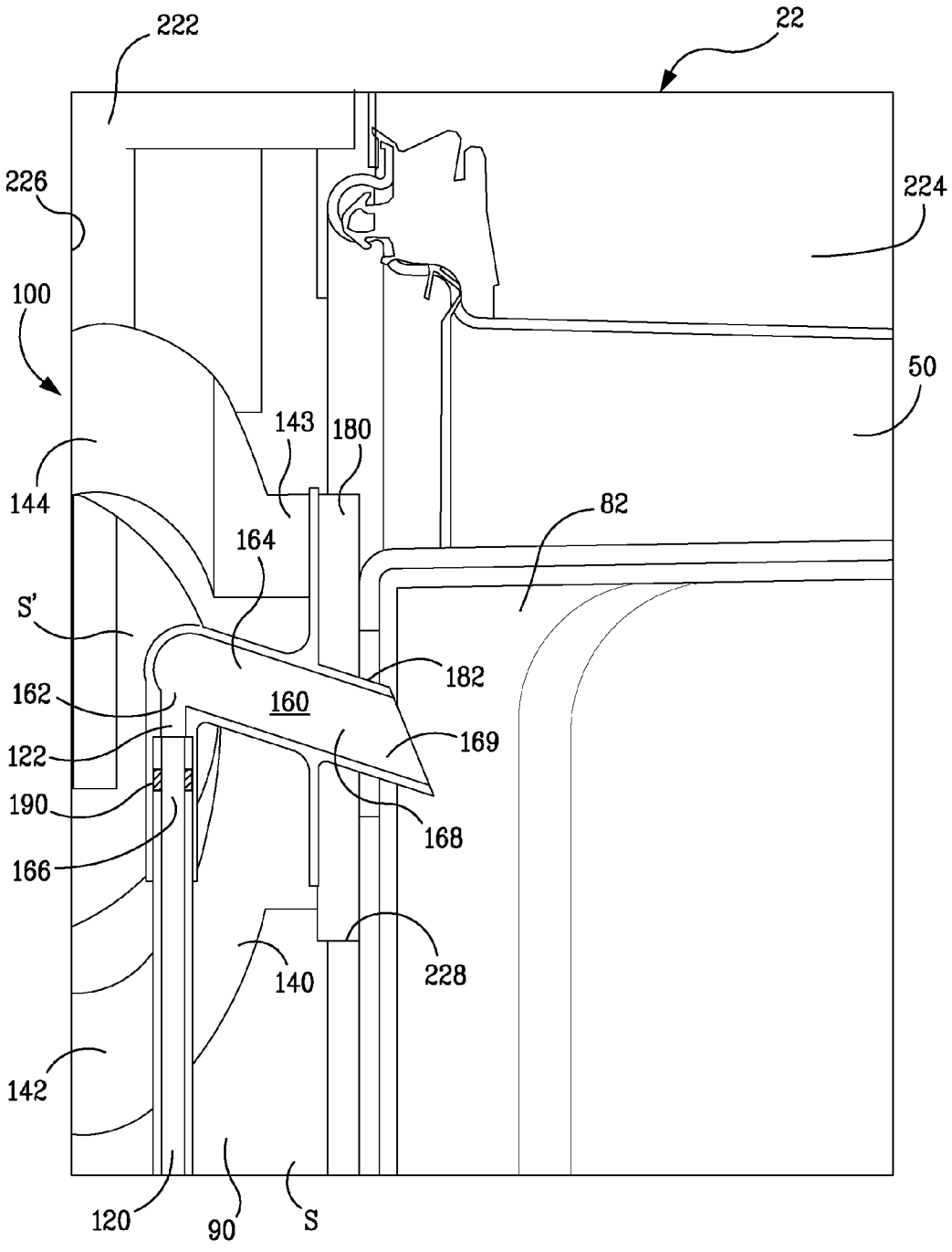

222
22
226
224
100
50
143
180
144
82
164
S'
182
162
160
169
122
190
168
166
140
228
142
120
90
S

FIG. 5

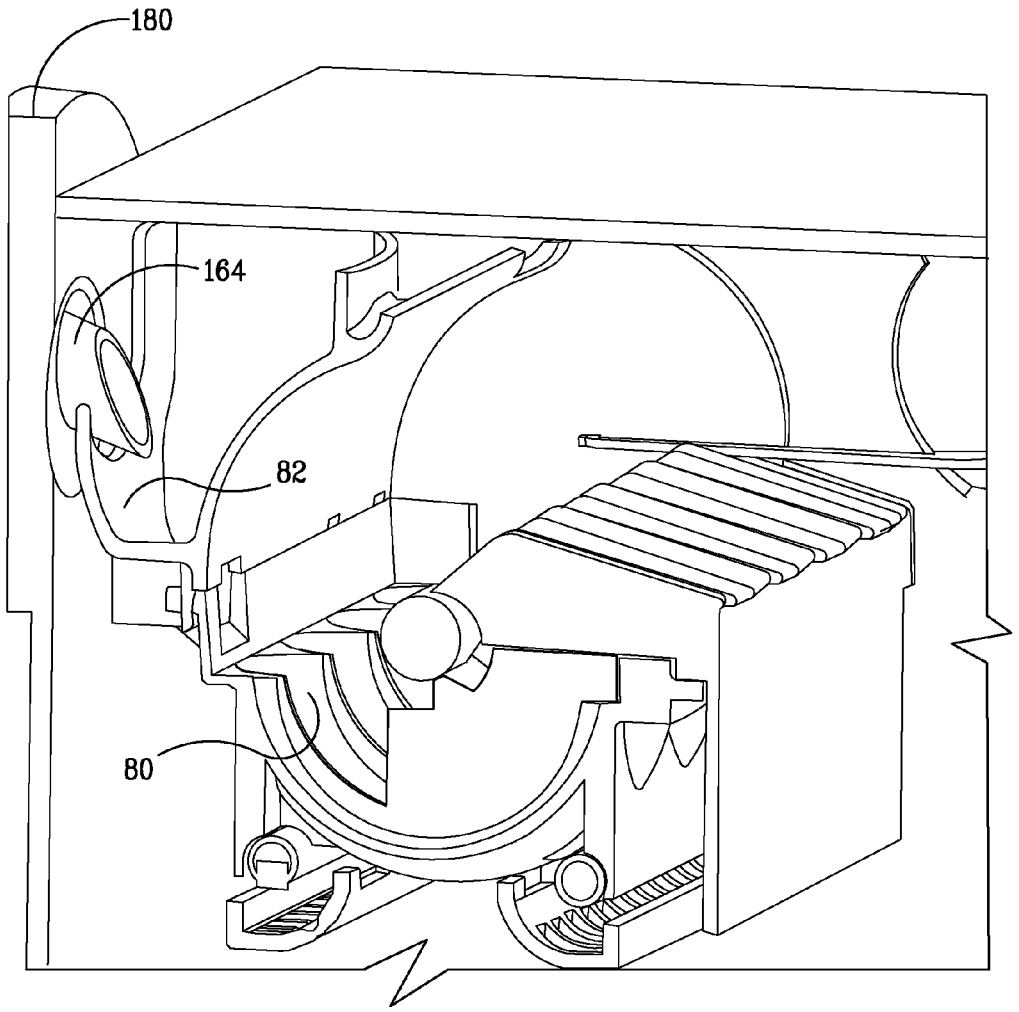


FIG. 6

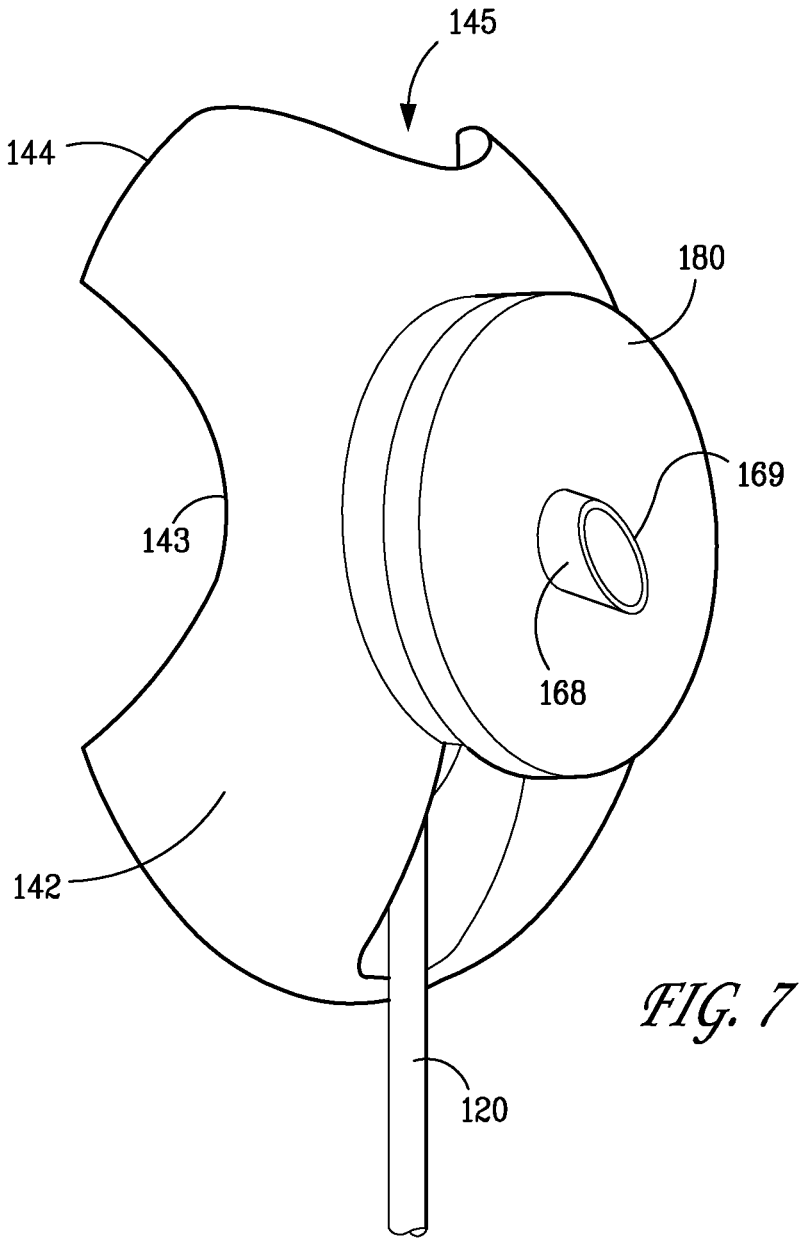


FIG. 7

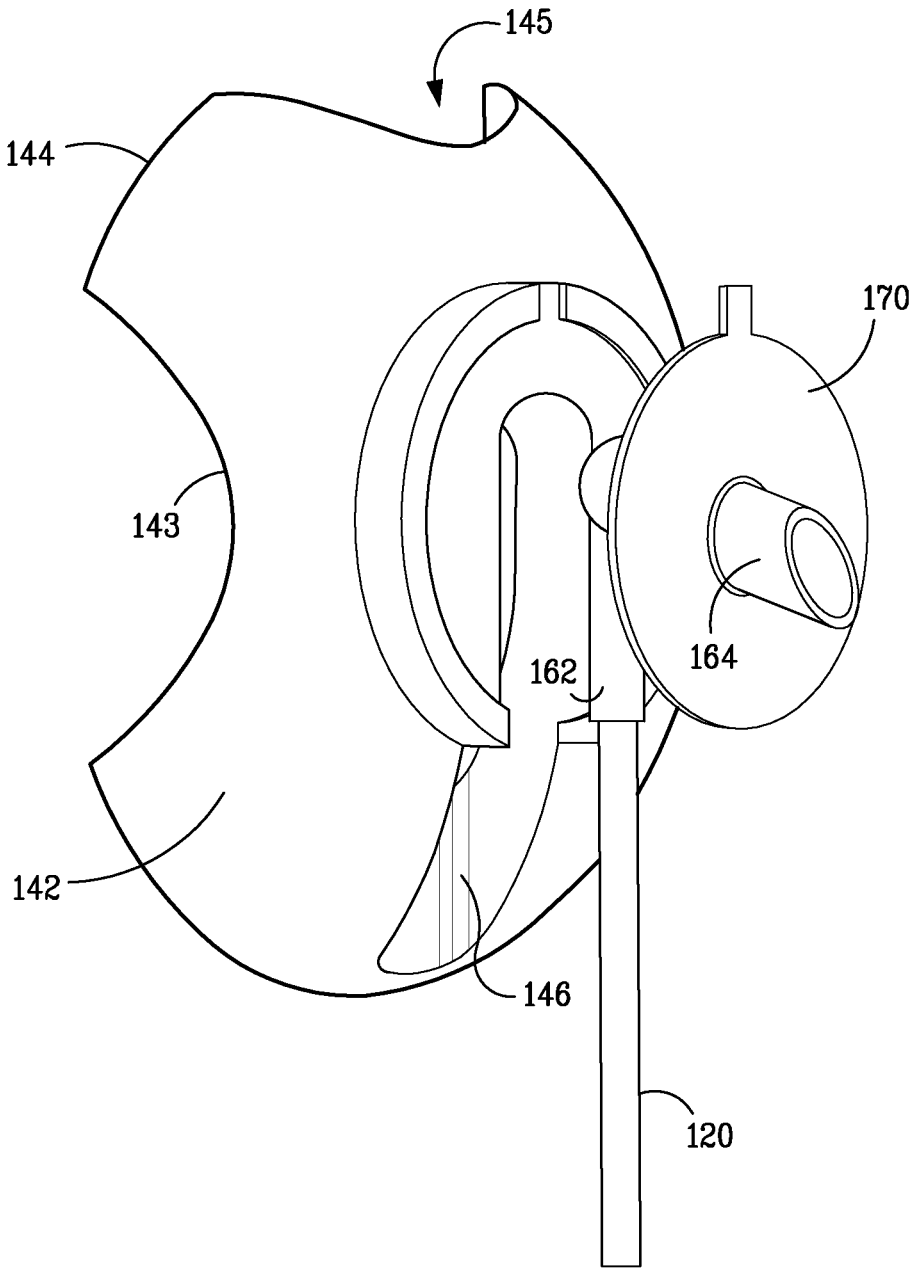


FIG. 8

WATER SUPPLY APPARATUS IN REFRIGERATOR

BACKGROUND OF THE INVENTION

The current disclosure relates generally to refrigerators. More specifically, the current disclosure relates to a water supply apparatus used in a refrigerator for conveying water to an icemaker of the refrigerator, a refrigerator door incorporating the water supply apparatus, and a refrigerator incorporating the door.

Generally, a refrigerator includes a freezer compartment and a fresh food compartment, which are partitioned from each other to store various foods at a low temperature in an appropriate state for a long time. It is now common practice in the art of refrigerators to provide an automatic icemaker to speed up the ice-making operation.

In a "bottom freezer" type refrigerator where the freezer compartment is arranged below a top fresh food compartment, convenience necessitates that the icemaker is disposed in the access door of the top mounted fresh food compartment and delivers ice through an opening in the access door of the fresh food compartment, rather than through the access door of the freezer compartment. In this case, a working medium (i.e., coolant), such as air or a mixture of propylene glycol and water, is cooled, directly or indirectly, by the cooling system. The working medium is then delivered through a passageway to the icemaker to maintain the icemaker at a temperature below the freezing point of water. To further improve consumer convenience, the icemaker has been integrated into the fresh food door of the refrigerator, to which end waterline is run through the fresh food door to supply purified water to the icemaker.

Traditionally, the waterline includes a water tube extending upwardly within the fresh food door. The water tube is typically a ¼ inch diameter waterline entering a fill cup disposed above the icemaker and in fluid communication with the icemaker. One disadvantage of the traditional water supply device is that excessive water splash can be created in the fill cup due to the size of the water tube. Another disadvantage of the traditional water supply device is that sweating on the outer surface of the fresh food door and freezing of the waterline adjacent to the icemaker cannot be effectively prevented. The freezing of the waterline can cause ice build-up in the water tube adjacent to the icemaker, which would in turn blocks water flow to the icemaker. Yet another disadvantage of the traditional water supply device is, when an open pour or so-called "clam-shell" foaming process (which will be described later) is used for forming the door, lining up the water supply with the fill cup can be difficult.

Therefore, a water supply device within the fresh food door of a refrigerator, which effectively prevents the occurrence of the above sweating and freezing as well as water splash and overcomes the difficulties in lining up the water supply with the fill cup, is desired.

BRIEF DESCRIPTION OF THE INVENTION

As described herein, the exemplary embodiments of the current invention overcome one or more of the above or other disadvantages known in the art.

One exemplary aspect of the present invention relates to a water supply apparatus disposed in a door of a refrigerator for conveying water to an icemaker of the refrigerator. The door includes an insulator disposed therein. The apparatus includes a water tube configured to deliver water from a water source, a support block attached to an inner surface of the door, a fill tube assembled to the support block and in fluid communication with the water tube, and a gasket disposed between the support block and the door and configured to seal the insulator in the door, the gasket having a hole through which the fill tube extends to convey the water from the water tube to the icemaker.

Another exemplary aspect of the present invention relates to a door for a refrigerator. The door includes an outer case forming an exterior of the door, and an inner case coupled with the outer case to form a backside of the door. The inner case and the outer case together define a space, in which an insulator is filled. The inner case defines a compartment in which an icemaker is provided. The door further includes a water tube extending in the space and configured to deliver water from a water source, a support block attached to an inner surface of the outer case, a fill tube assembled to the support block and connected to the water tube, and a gasket disposed between the support block and the inner case and configured to seal the insulator in the space, the gasket having a hole through which the fill tube extends into the compartment for conveying the water from the water tube to the icemaker.

Still another exemplary aspect of the present invention relates to a refrigerator. The refrigerator includes a fresh food compartment, a freezer compartment separated from the fresh food compartment, an access door for selectively opening and closing the fresh food compartment, and an icemaker disposed within the access door and configured to dispense at least one of ice and chilled water to a user upon stimulus. The access door includes an outer case forming an exterior of the access door and an inner case coupled with the outer case to form a backside of the access door. The inner case and the outer case define a space in which an insulator is filled. The inner case further defines a sub-compartment at the backside of the access door, the icemaker being disposed within the sub-compartment. The access door further includes a water tube extending in the space defined by the inner case and the outer case, and configured to deliver water from a water source. The access door further includes a support block attached to an inner surface of the outer case, a fill tube assembled to the support block and connected to the water tube, and a gasket disposed between the support block and the inner case and configured to seal the insulator in the space. The gasket has a hole through which the fill tube extends into the sub-compartment for conveying the water from the water tube to the icemaker.

These and other aspects and advantages of the current invention will become apparent from the following detailed description considered in conjunction with the accompanying drawings. It is to be understood, however, that the drawings are designed solely for purposes of illustration and not as a definition of the limits of the invention, for which reference should be made to the appended claims. Moreover, the drawings are not necessarily drawn to scale and, unless otherwise indicated, they are merely intended to conceptually illustrate the structures and procedures described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a refrigerator in accordance with an exemplary embodiment of the present invention;

FIG. **2** is a perspective view of the refrigerator of FIG. **1** with the refrigerator doors in an open position and the freezer door removed for clarity;

FIG. **3** is a partial exploded view of a door having an icemaker disposed therein, in accordance with an exemplary embodiment of the present invention;

FIG. **4** is a partial elevation view of the door in accordance with an exemplary embodiment of the present invention;

FIG. **5** is a partial cross section view of the door along lines **5-5** of FIG. **4**, schematically illustrating a water supply apparatus in accordance with an exemplary embodiment of the present invention, the water supply apparatus being incorporated in the door;

FIG. **6** is a partial perspective view of the door, illustrating the positional relationship between the water supply apparatus and the icemaker;

FIG. **7** is a perspective view of the water supply apparatus shown in FIG. **5**; and

FIG. **8** is an exploded perspective view of the water supply apparatus shown in FIG. **5**.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS OF THE INVENTION

FIG. **1** illustrates an exemplary "bottom freezer" refrigerator **10**. While the embodiments are described herein in the context of a specific refrigerator, it is contemplated that the embodiments may be practiced in other types of refrigerators. Therefore, as the benefits of the herein described embodiments accrue generally to water conveying and ice dispensing in a refrigerator, the description herein is for exemplary purposes only and is not intended to limit practice of the invention to a particular type of refrigeration appliance or machine, such as the refrigerator **10**.

The refrigerator **10** includes a fresh food compartment **12**, which can be accessed through one or more access doors for selectively opening and closing the fresh food compartment **12**, such as French doors **22** and **24** shown in FIG. **1**. However, it should be understood that a single access door can be used instead of the French doors **22** and **24**. The refrigerator **10** further includes a freezer compartment **14**, which can be accessed through at least one access door, such as a drawer **26**.

The refrigerator **10** is contained within a casing **16**. The casing **16** is normally formed by folding a sheet of a suitable material, such as pre-painted steel, into an inverted U-shape to form top and sidewalls of the casing **16**. A bottom wall of the casing **16** is normally formed separately, and attached to the sidewalls and to a bottom frame that provides support for the refrigerator **10**.

FIG. **2** illustrates the refrigerator **10** with the French doors **22** and **24** in an open position and the drawer **26** removed. As shown, the fresh food compartment **12** and freezer compartment **14** are arranged in a bottom freezer configuration. The refrigerator **10** further includes inner liners **18** and **20**. The inner liners **18** and **20** are molded from a suitable plastic material to form the fresh food compartment **12** and the freezer compartment **14**, respectively. Alternatively, the liners **18** and **20** may be formed by bending and welding a sheet of a suitable metal, such as steel. The space between the casing **16** and the liners **18** and **20** as well as the space between the liners **18** and **20** are filled with foamed-in-place insulation. The illustrative embodiment includes two separate liners **18** and **20** as it is a relatively large capacity unit and separate liners add strength and are easier to maintain within manufacturing tolerances.

The insulation in the space between the liners **18** and **20** is covered by another strip of suitable material, which is also commonly referred to as a mullion **28**. The mullion **28** in one embodiment is formed of an extruded ABS material. The refrigerator **10** may further include a shelf **30** and slide-out drawer **32**, provided in the fresh food compartment **12** to support items being stored therein. A shelf **34** can be further provided in the freezer compartment **14**.

In the shown embodiment, each of the French doors **22** and **24** is mounted by a top hinge assembly **36** and a bottom hinge assembly **37** to rotate about its outer vertical edge between a closed position, as shown in FIG. **1**, and an open position, as shown in FIG. **2**.

Referring back to FIG. **1**, on the exterior of the refrigerator **10**, there is disposed an external access area **40** to receive ice cubes and/or drinking water. In response to a user's input, such as a stimulus for dispensing water, a water dispenser **42** allows an outflow of drinking water into a user's receptacle. In response to a user's input, such as a stimulus for dispensing ice, an ice dispenser outlet **44** of an ice making, storage and dispensing compartment **50** (shown in FIGS. **2** and **3**) allows an outflow of whole ice cubes into a user's receptacle.

As shown in FIG. **2**, the ice making, storage and dispensing compartment **50** is defined in the interior of the left French door **22** of the refrigerator **10**.

FIG. **3** schematically illustrates an exploded perspective view of the left French door **22** and the ice making, storage and dispensing compartment **50**. An ice storage bin **60** and a driving assembly **70** can be assembled into the compartment **50**, drivingly engageable with each other. An icemaker **80**, such as an electronic icemaker, can be assembled into the compartment **50** and disposed above the ice storage bin **60**.

As shown in FIG. **3**, the French door **22** includes an outer case **222** forming an exterior of the door **22** and an inner case **224** coupled with the outer case **222** to form a backside of the door **22**. Typically, the outer case **222** is made of metal and the inner case **224** is made of plastic materials. A space S (shown in FIG. **5**) is defined between the outer case **222** and the inner case **224**, in which an insulator **90** (shown in FIG. **5**), such as a foaming liquid, can be filled.

For example, for the assembly of the door **22**, the outer case **222** and the inner case **224** are integrated through a so-called "clam-shell" design, in which the metal outer case **222** and the plastic inner case **224** are molded together like a clam to define the space S. The ice making, storage and dispensing compartment **50** is defined at the backside of the door **22**, by the inner case **224**. After the molding of the outer case **222** and the inner case **224**, the ice storage bin **60**, driving assembly **70** and the icemaker **80** are installed in the ice making, storage and dispensing compartment **50** of the inner case **224**. Suitable material for the foaming liquid includes, but is not limited to, polyurethane.

The waterline for supplying cold purified water to the ice maker **80** typically runs through a door hinge (such as the hinge **36** or **37** of the French door **22**) and the foaming liquid to convey the water from the metal side of the door to the plastic side of the door.

FIG. **4** is a partial elevation view of the ice making, storage and dispensing compartment **50**, with the ice storage bin **60** removed to better depict the inside of the ice making, storage and dispensing compartment **50**. FIG. **5** is a partial cross section view of the French door **22** along lines **5-5** of FIG. **4**, illustrating a water supply apparatus **100** according to an exemplary embodiment of an aspect of the present invention. FIG. **6** is a partial perspective view of the French door **22**, illustrating the positional relationship between the water supply apparatus **100** and the icemaker **80**.

As shown, the water supply apparatus **100** is disposed in the space S defined by the outer case **222** and the inner case **224** of the French door **22**. The water supply apparatus **100** includes a water tube **120** configured to deliver water from a water source (not shown), a support block **140** attached to an

inner surface **226** of the outer case **222**, and a fill tube **160** assembled to the support block **140** and in fluid communication with the water tube **120**.

In the shown embodiment, the fill tube **160** includes a first tube section **162** and a second tube section **164**, connected with each other angularly. The first tube section **162** and the second tube section **164** can have similar or different sizes or diameters. Optionally, the second tube section **164** extends downwardly to form an acute angel with the first tube section **162**, so that there is no water accumulation in the second tube section **164**, which assists in preventing water freezing in the second tube section **164**.

The water tube **120** extends upwardly in the foaming liquid insulator **90**, and an upper end **122** of water tube **120** engages a lower end **166** of the first tube section **162** to implement the fluid communication between the water tube **120** and the fill tube **160**. The lower end of the water tube **120** is connected to the water supply line (not shown) of the refrigerator **10**.

The water supply apparatus **100** further includes a gasket **180**, which serves as an interface between the assembly of the support block **140** and the fill tube **160** and the inner case **224** of door **22**. For example, the gasket **180** is properly dimensioned and positioned to caulk the gap between the support block **140** and the inner case **224**, thereby positively sealing the foaming liquid insulator **90** within the space S between the outer case **222** and the inner case **224**. For example, the gasket **180** can be embedded in a recess **228** of the inner case **224** to provide a better sealing effect.

Suitable materials for forming the gasket **180** include, but are not limited to, closed cell polyethylene. The gasket **180** has a hole **182**, through which the second tube section **164** of the fill tube **160** extends to convey the water from the water tube **120** to the fill cup **82** above the icemaker **80**. Once the second tube section **164** passes through the hole **182**, an end **168** of the second tube section **164** is exposed to the fill cup **82** in the compartment **50**. The exposed end **168** can be formed to have a slanted terminus **169**, which can effectively prevent occurrence of water splashing when the water is conveyed through the fill tube **160**.

FIG. **7** is a perspective view of the water supply apparatus **100**. FIG. **8** is an exploded perspective view of the water supply apparatus **100**, with the gasket **180** removed to better depict the support block **140** and the fill tube **160**.

As shown, according to an exemplary embodiment, the support block **140** includes a substantially bowl-shaped support body **142** and a base **143** integral with the support body **142**. Optionally, the base **143** is substantially round, as shown. However, the base **143** can be of any suitable shape and profile. The edge **144** of the support body **142**, distal to the base **143**, is attached to the inner surface **226** of the outer case **222**. For example, the support block **140** can be integrally molded with the outer case **222** at the edge **144**. At least one cutout **145** is provided in the bowl-shaped support body **142** along the edge **144** of the support body **142**, for allowing the foaming liquid to enter a substantially bowl-shaped space S' defined by the support body **142**. Although two cutouts **145** are shown in FIGS. **7** and **8**, a person of ordinary skill in the art understands that the number, size and shape of the cutouts are not limited to what are shown, as long as the foaming liquid can readily flow into the space S' through the cutouts. Suitable materials for forming the support block **140** include, but are not limited to, expanded polystyrene.

The bowl-shaped support body **142** provides a structural support for fixing the fill tube **160** and the water tube **120** with respect to the outer case **222** and the inner case **224**, so as to improve the structural integrity of the entire water supply apparatus **100**. On the other hand, the bowl-shaped support body **142** allows sufficient foaming liquid to enter the space S' between the support body **142** and the inner surface **226** of the outer case **222**, thereby ensuring a satisfactory heat insulation to prevent sweating from happening on the outside of the door **22**.

As shown in FIG. **8**, the fill tube **160** further includes a flange **170** extending substantially radially from the second tube section **164**. Optionally, the flange **170** is substantially in the form of a round disc and substantially complementary to the base **143** of the support body **142**. The support block **140** has an opening **146** extending through the support body **142** and the base **143**. The opening **146** is configured to allow the fill tube **160** to partially enter the opening **146**, until the flange **170** of the fill tube **160** engages the base **143** of the support block **140**. After the flange **170** of the fill tube **160** engages the base **143** of the support block **140**, the gasket **180** is applied to engage the other side of the flange **170** and close the gap between the flange **170** and the inner case **224**, so that the entire water supply apparatus **100** is fixed properly in the door **22**. Optionally, the opening **146** can be configured to also allow a portion of the water tube **120**, connected to the fill tube **160**, to extend in the opening **146**.

Referring back to FIG. **5**, after the water supply apparatus **100** is mounted in position, water supplied from a water source and a waterline of the refrigerator **10** is delivered through the water tube **120** and subsequently the fill tube **160** into the fill cup **82** in fluid communication with the icemaker **80**. Since the temperature of the conveyed water can be much lower than the dew point of the ambient air, sweating on the outside of the outer case **222** may happen. On the other hand, the working temperature in the compartment **50** for the icemaker **80** is much lower than the temperature of the conveyed water. Thus, water freezing may happen in the fill tube **160** (especially the first tube section **162**) and the water tube **120** if the compartment **50** and the tubes are close.

The water supply apparatus **100**, according to an exemplary embodiment of the present invention, can effectively prevent both the sweating and freezing from happening. As previously discussed, the unique design of the bowl-shaped support body **142** ensures that sufficient foaming liquid be filled in the space S' between the support body **142** and the inner surface **226** of the outer case **222**. Considering the foaming liquid has very high insulating properties, sweating on the outside of the door **22** can be effectively prevented from happening.

In addition, the dimensions of the support block **140** and the gasket **180** can be selected to place the fill tube **160** (especially the first tube section **162**) and the water tube **120** in an optimal position between the outer case **222** and the inner case **224**, so that the distance between the tubes and the outside surface of the outer case **222** will not cause sweating and the distance between the tubes and the compartment **50** will not cause freezing.

Optionally, the water supply apparatus **100** can further includes a heater **190** wrapped around the fill tube **160**, for heating the fill tube **160** in a controlled manner to clear any ice build-up in the fill tube **160** and/or defrost the fill tube. The heater **190** can be wrapped around the first tube section **162** or the second tube section **164**. Additional heaters can be further provided for the water tube **120**.

The fundamental novel features of the invention as applied to various specific embodiments thereof have been shown, described and pointed out, it will also be understood that various omissions, substitutions and changes in the form and details of the devices illustrated and in their operation, may be made by those skilled in the art without departing from the spirit of the invention. For example, it is expressly intended

that all combinations of those elements and/or method steps which perform substantially the same function in substantially the same way to achieve the same results are within the scope of the invention. Moreover, it should be recognized that structures and/or elements and/or method steps shown and/or described in connection with any disclosed form or embodiment of the invention may be incorporated in any other disclosed or described or suggested form or embodiment as a general matter of design choice. It is the intention, therefore, to be limited only as indicated by the scope of the claims appended hereto.

What is claimed is:

1. A water supply apparatus disposed in a door of a refrigerator for conveying water to an icemaker of the refrigerator, the door comprising an insulator disposed therein, the apparatus comprising:

a water tube configured to deliver water from a water source;

a support block attached to an inner surface of the door;

a fill tube assembled to the support block, the fill tube being in fluid communication with the water tube; and

a gasket disposed between the support block and the door and configured to seal the insulator in the door, the gasket having a hole through which the fill tube extends to convey the water from the water tube to the icemaker,

wherein the support block comprises a support body attached to the inner surface of the door, a base integral with the support body, and at least one cutout,

wherein the support body has a substantially bowl-shaped profile to define a substantially howl-shaped space between the support body and the inner surface of the door, and

wherein the support block is in direct contact with an inner surface of an outer case of the door, said support block disposed between an inner case and the outer case of the door.

2. The water supply apparatus according to claim **1**, wherein the at least one cutout allows the insulator to enter the substantially bowl-shaped space.

3. The water supply apparatus according to claim **1**, wherein the fill tube comprises a first tube section and a second tube section connected to each other angularly, the first tube section being in fluid communication with the water tube, the second tube extending through the hole of the gasket to expose an end thereof to the icemaker.

4. The water supply apparatus according to claim **3**, wherein the exposed end of the second tube section comprises a slanted terminus.

5. The water supply apparatus according to claim **3**, wherein the fill tube further comprises a flange extending radially from the second tube section, the gasket disposed between the flange and the door for sealing the insulator in the door.

6. The water supply apparatus according to claim **5**, wherein the support block has an opening extending through the support body and the base, the opening being configured to allow the fill tube to partially enter the opening until the flange of the fill tube engages the base.

7. The water supply apparatus according to claim **1**, further comprising a heater wrapped around the fill tube for heating fill tube in a controlled manner, thereby preventing occurrence of water freezing in the fill tube.

8. A door for a refrigerator, comprising:

an outer case forming an exterior of the door;

an inner case coupled with the outer case to form a backside of the door, the inner case and the outer case defining a space in which an insulator is filled, the inner case further defining a compartment at the backside of the door, in which an icemaker is provided;

a water tube extending in the space and configured to deliver water from a water source;

a support block;

a fill tube assembled to the support block and connected to the water tube; and

a gasket disposed between the support block and the inner case and configured to seal the insulator in the space, the gasket having a hole through which the fill tube extends into the compartment for conveying the water from the water tube to the icemaker,

wherein the support block comprises a support body attached to an inner surface of the door, a base integral with the support body, and at least one cutout,

wherein the support body has a substantially bowl-shaped profile to define a substantially bowl-shaped space between the support body and the inner surface of the door, and

wherein the support block is in direct contact with an inner surface of the outer case of the door, said support block disposed between the inner case and the outer case of the door.

9. The door according to claim **8**, wherein the at least one cutout allows the insulator to enter the substantially bowl-shaped space.

10. The door according to claim **8**, wherein the fill tube comprises a first tube section and a second tube section connected to each other angularly, the first tube section being connected to the water tube, the second tube extending through the hole of the gasket to expose an end thereof to the icemaker.

11. The door according to claim **10**, wherein the exposed end of the second tube section comprises a slanted terminus.

12. The door according to claim **11**, wherein the fill tube further comprises a flange extending radially from the second tube section, the gasket disposed between the flange and the door for sealing the insulator in the door.

13. The door according to claim **12**, wherein the support block has an opening extending through the support body and the base, the opening being configured to allow the fill tube to partially enter the opening until the flange of the fill tube engages the base.

14. The door according to claim **8**, further comprising a heater wrapped around the fill tube for heating fill tube in a controlled manner, thereby preventing occurrence of water freezing in the fill tube.

15. A refrigerator comprising:

a fresh food compartment;

a freezer compartment separated from the fresh food compartment;

an access door for selectively opening and closing the fresh food compartment; and

an icemaker disposed within the access door and configured to dispense at least one of ice and chilled water to a user upon stimulus,

wherein the access door comprises:

an outer case forming an exterior of the access door,

an inner case coupled with the outer case to form a backside of the access door, the inner case and the outer case defining a space in which an insulator is filled, the inner case further defining a sub-compartment at the backside of the access door, the icemaker being disposed within the sub-compartment;

a water tube extending in the space and configured to deliver water from a water source;

a support block;

a fill tube assembled to the support block and connected to the water tube; and

a gasket disposed between the support block and the inner case and configured to seal the insulator in the space, the gasket having a hole through which the fill tube extends into the sub-compartment for conveying the water from the water tube to the icemaker,

wherein the support block comprises a support body attached to an inner surface of the access door, a base integral with the support body, and at least one cutout,

wherein the support body has a substantially bowl-shaped profile to define a substantially bowl-shaped space between the support body and the inner surface of the access door, and

wherein the support block is in direct contact with an inner surface of the outer case of the door, said support block disposed between the inner case and the outer case of the door.

16. The refrigerator according to claim **15**, further comprising a hinge assembly for mounting the access door to the fresh food compartment, the water tube extending through the hinge assembly to deliver water from a water source.

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